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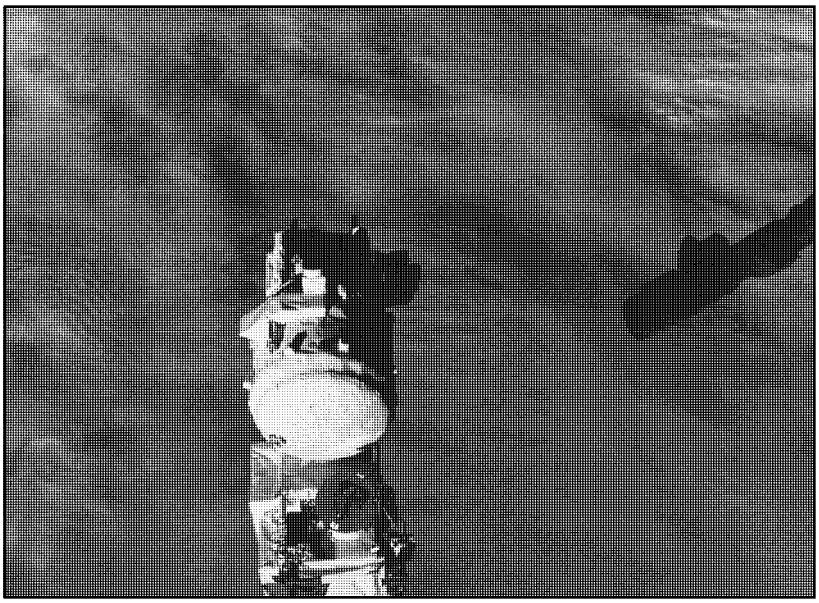
Mission Highlights STS-39

Space Shuttle *Discovery*

April 28 - May 6, 1991

Commander:
Michael L. Coats, Capt., USN
Pilot:
L. Blaine Hammond, Lt. Col., USAF
Mission Specialists:
Gregory J. Harbaugh
Donald R. McMonagle, Lt. Col., USAF
Guion S. Bluford, Col., USAF
C. Lacy Veach
Richard J. Hieb



The SPAS II/IBSS spacecraft is about to be retrieved with *Discovery*'s remote manipulator system arm following a period of free-flight.

Major Mission Accomplishments

- Conducted a wide range of experiments supporting the U.S. Air Force's studies of upper atmospheric phenomena and the Strategic Defense Initiative Organization's work in characterizing rocket engine exhaust plumes.
- Made the first rocket engine plume observations ever outside Earth's atmosphere. (Sponsored by the Strategic Defense Initiative Organization.)
- Executed a record 35 firings of the orbital maneuvering and reaction control systems.
- Conducted extensive studies of upper atmospheric aurora and airglow limb emissions. (Sponsored by the USAF Systems Command-Space Systems Division.)
- Deployed three Chemical Release Observation (CRO) subsatellites for simultaneous space and ground observations of gas releases. (Sponsored by the USAF Systems Command-Space Systems Division.)
- Deployed a classified Multipurpose Experiment Canister. (Sponsored by the USAF Space Systems Division.)
- Collected infrared, ultraviolet, and visible light data on auroras, solar spectra, Earth airglow limb, and stellar objects to learn how better to distinguish natural from human-made phenomena. (Sponsored by the Strategic Defense Initiative Organization.)
- Took advantage of the high inclination of *Discovery*'s orbit to take color and infrared pictures of important Earth surface features and phenomena, including Lake Baikal in the USSR, oil field fires in Kuwait, and the devastating typhoon in the Indian Ocean.
- First Space Shuttle crew consisting of seven NASA astronauts.

With its touchdown at the Kennedy Space Center on May 6, 1991, the Space Shuttle *Discovery* completed one of the most complicated shuttle flights to date. STS-39 was an unclassified Department of Defense mission that sought to enhance national security by gathering scientific data essential to the development of advanced missile detection systems. The seven-member crew of *Discovery* conducted a variety of sophisticated experiments that included the deployment of five spacecraft (SPAS II/IBSS, Multipurpose Experiment Canister, and three CRO) from the payload bay and the retrieval of one of these spacecraft later. Because of their high orbital inclination (57 degrees with respect to Earth's equator) they flew directly over most major land masses on Earth and were able to take extensive photos of Earth's resources.

One of the major payloads on STS-39 was a cluster of experiments sponsored by the Strategic Defense Initiative Organization and the Air Force Systems Command's Space Systems Division. The Air Force Program-675 (AFP-675) payload consisted of five instruments designed to observe targets—such as the atmosphere, aurora, and stars—in infrared, far ultraviolet, and X-ray wavelengths. One of the most important experiments in this cluster was CIRRIS (Cryogenic Infrared Radiance Instrumentation for Shuttle). Using an infrared detector, which required chilling with supercold liquid helium to achieve maximum sensitivity, the CIRRIS instrument studied airglow and auroral emissions in Earth's upper atmosphere to determine their characteristics in the infrared region of the electromagnetic spectrum. Due to a faster than anticipated consumption of liquid helium coolant, early completion of the CIRRIS experiment became a priority and resulted in delaying the deployment of the SPAS II/IBSS spacecraft by 24 hours. During the operation of CIRRIS, both STS-39 crew and scientists on the ground were treated to spectacular and unusually intense auroral displays. As *Discovery* passed through the aurora australis (southern lights) over the South Atlantic Ocean, STS-39 commander Mike Coats reported, "It's just like flying through a curtain of light." Understanding auroras is important, because the radiations they produce can interfere with early missile detection. As a result of the rescheduling and the efforts of the STS-39 crew, CIRRIS scientists were rewarded with 50 percent greater return of data than they had planned.

STS-39 crew: Center: Michael L. Coats. Moving clockwise from top center: L. Blaine Hammond, Richard J. Hieb, Gregory J. Harbaugh, C. Lacy Veach, Donald R. McMonagle, Guion S. Bluford.

Other experiments in the AFP-675 payload included the FAR Ultraviolet Cameras (FAR UV), Uniformly Redundant Array (URA), Horizon Ultraviolet Program (HUP), and the Quadrupole Ion-Neutral Mass Spectrometer (QINMS). URA, HUP, and QINMS were adversely affected after about four hours of operation on flight day one when two tape recorders gathering data failed. In a convincing demonstration of the value of a human presence in orbit, STS-39 crew members, through a complicated bypass repair operation, successfully rerouted data from these instruments to an orbiter antenna. The data were then transmitted directly to two Tracking Data Relay Satellites for relay to the ground, fulfilling the objectives of those four experiments.

On flight day four, *Discovery*'s remote manipulator system arm was used by the crew to grasp the SPAS II/IBSS spacecraft. The SPAS II (Shuttle Pallet Satellite carrier) is a free-flying satellite that can provide support for a variety of instruments and permit them to be independently flown in space from the Space Shuttle. When lifted out of the payload bay, it can be released to operate in orbit at varying distances from the Shuttle. At the completion of its tasks, it is captured by the arm and replaced in the payload bay

for return to Earth.

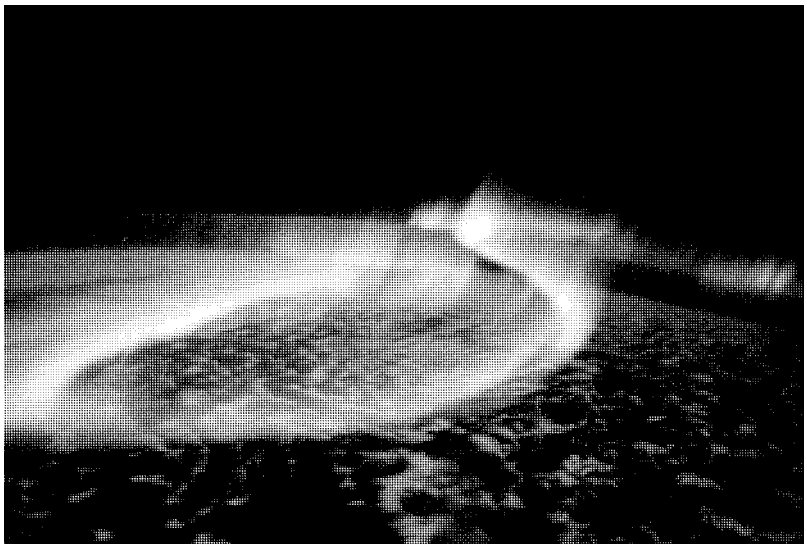
On STS-39, the SPAS II spacecraft was a part of the IBSS (Infrared Background Signature Survey) experiment sponsored by the Strategic Defense Initiative Organization. Two scientific instruments were mounted on the SPAS II; an infrared telescope and the Arizona Imaging Spectrometer (AIS). The infrared telescope contained detectors for creating infrared images and for spectral analysis. The AIS contained detectors capable of creating images in the ultraviolet, infrared, and visible parts of the spectrum.

After its deployment on the SPAS II carrier spacecraft, the IBSS experiment instruments were used to image and measure the spectral nature of rocket exhaust plumes. *Discovery* was maneuvered away from IBSS to various distances ranging from 2 to nearly 11 km. By firing *Discovery*'s reaction control engines and orbital maneuvering system engines while positioned in a variety of different attitudes, these experiments permitted scientists to compare known firing directions, burn durations, and chemical compositions of *Discovery*'s exhaust gases to the spectral data collected by the instruments on the IBSS. Such data will aid future missile detection systems to determine the trajectory of missiles more accurately. In additional studies with the IBSS, measurements of chemical releases were made. In one experiment, four different gases were released from containers in the payload bay and observed by the IBSS sensors looking back at the orbiter. These gases included xenon, neon, carbon dioxide, and nitrous oxide. In addition, three small CRO subsatellite canisters carrying various chemicals were ejected from *Discovery*'s payload bay. After the canisters had drifted to distances ranging from 50 to 95 km away from *Discovery*, they each released short-lived clouds of chemical rocket fuels and oxidizers. Simultaneous observations of these releases were made by the IBSS in orbit and with Earth-based instruments at the Vandenburg Air Force Base in California. Observation of the third release was made following the SPAS II/IBSS retrieval. SPASII/IBSS was raised above *Discovery*'s payload bay at the end of the remote manipulator system arm.

A great many other observations were made with the IBSS instrument in the free-flying mode, attached to the end of the arm, and from within the payload bay. Included were studies of Earth limb, aurora, orbiter environment, stars, and Shuttle glow.

During the mission, STS-39 crew members took advantage of their high view of Earth to take many pictures that can be used by researchers in the study of environmental problem areas. Astronauts photographed black smoke palls from the oil field fires in Kuwait and smoke palls from fires in Central America that had drifted as far north as Texas and as far east as Florida. They observed, from above, the typhoon in the Indian Ocean's Bay of Bengal that devastated Bangladesh and left more than 100,000 people dead. Over the Soviet Union, crew members photographed Lake Baikal, which is of interest to geologists because of its location in the northernmost part of the area where the Indian continental plate is colliding with the Eurasian plate.

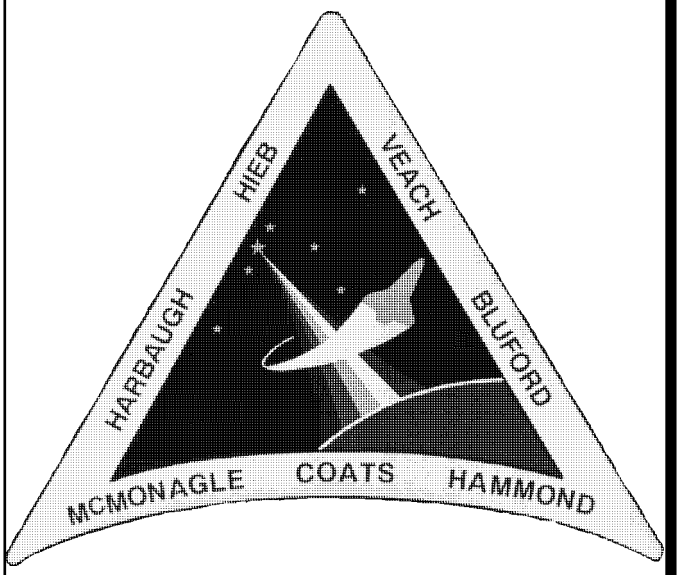
Although the STS-39 mission experienced occasional instrument problems during the flight, teamwork between the crew and mission control permitted a high rate of data return and the accomplishment of virtually all mission objectives. The mission concluded with *Discovery*'s landing at the Kennedy Space Center in Florida when high crosswinds at the planned landing site in California prohibited a safe landing there.



The aurora australis (southern lights) as seen by the crew of STS-39.

Mission Facts

Orbiter: *Discovery*
Mission Dates: April 28-May 6, 1991
Commander: Michael L. Coats, Capt., USN
Pilot: L. Blaine Hammond, Lt. Col., USAF
Mission Specialist: Gregory J. Harbaugh
Mission Specialist: Donald R. McMonagle, Lt. Col., USAF
Mission Specialist: Guion S. Bluford, Col., USAF
Mission Specialist: C. Lacy Veach
Mission Specialist: Richard J. Hieb
Mission Duration: 8 days, 7 hours, 22 minutes
Distance Traveled: 5,594,750 km
Orbit Inclination: 57 degrees
Orbits of Earth: 134
Orbital Altitude: 260 km
Payload Weight Up: 5,102 kg
Orbiter Landing Weight: 96,045 kg
Landed: Kennedy Space Center
Payloads and Experiments:
AFP-675
SPAS-II/IBSS
Space Test Payload-1
Multi-Purpose Experiment Canister
Chemical Release Observation
Critical Ionization Velocity
Radiation Monitoring Experiment-III
Cloud Logic to Optimize the Use of Defense Systems
Educational Activities
Educational videotaping



STS 39-Crew Patch

Crew Biographies

Commander: Michael L. Coats (Capt., USN). Michael Coats was born in Sacramento, California but considers Riverside, California his hometown. He graduated from the U.S. Naval Academy and earned a master of science degree in aeronautical engineering from the U.S. Naval Post Graduate School. Coats was a combat pilot in Southeast Asia and a test pilot before joining NASA. He served as the pilot of the STS-41D mission and commander of STS-29.

Pilot: L. Blaine Hammond, Jr. (Lt. Col., USAF). Blaine Hammond was born in Savannah, Georgia and received a bachelor of science degree from the U.S. Air Force Academy and a master of science degree from the Georgia Institute of Technology. Before joining NASA, he was an Air Force pilot and a test pilot instructor. This was his first flight on the Space Shuttle.

Mission Specialist: Gregory J. Harbaugh. Gregory Harbaugh was born in Cleveland, Ohio but considers Willoughby, Ohio his hometown. He attended Purdue University and received a bachelor of science degree in aeronautical engineering. He also earned a master of science degree in physical sciences from the University of Houston-Clear Lake. Harbaugh served in engineering and management positions at NASA before becoming an astronaut. This was his first space flight.

Mission Specialist: Donald R. McMonagle (Lt. Col., USAF). Donald McMonagle comes from Flint, Michigan and received a bachelor of science degree in aeronautical engineering from the Air Force Academy and a master of science degree in mechanical engineering from California State University-Fresno. He has been an Air Force pilot and test pilot. This was his first space flight.

Mission Specialist: Guion S. Bluford (Col., USAF). Guion Bluford was born in Philadelphia, Pennsylvania and received a bachelor of science degree in aerospace engineering from Pennsylvania State University and a master of science degree in the same subject from the Air Force Institute of Technology. He earned a doctorate in aerospace engineering from the Air Force Institute of Technology and a master of business administration degree from the University of Houston-Clear Lake. Bluford has flown on the STS-8 and STS 61-A missions.

Mission Specialist: C. Lacy Veach. Lacy Veach was born in Chicago, Illinois but considers Honolulu, Hawaii his hometown. He earned a bachelor of science degree in engineering management from the Air Force Academy. He has been a fighter pilot and a member of the Thunderbirds Air Force Demonstration Squadron. Veach joined NASA as an engineer and research pilot before becoming an astronaut. This was his first space flight.

Mission Specialist: Richard J. Hieb. Richard Hieb was born in Jamestown, North Dakota and earned a bachelor of arts degree in math and physics from Northwest Nazarene College and a master of science degree in aerospace engineering from the University of Colorado. Before becoming an astronaut, he worked for NASA in mission control and specialized in rendezvous and proximity operations.